United States Department of Agriculture
Forest Service
Northeastern Area, Region 8
NA-FB/M-11

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IS YOUR SOIL DEAD?

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Is your soil lifeless? Soils need to drink and breathe, somewhat like plants and animals, in order to provide the proper environment for good plant growth. However, compacted soils can't drink, breathe or develop. Soil compaction is a measure of how closely soil particles are packed together. A loose friable soil will have a substantial portion of its volume occupied by spaces or pores between the soil particles. The number, size and distribution of these pores directly influence the movement of water and gases through the soil. Soil composition occurs when pores between soil particles are lost and air and water cannot circulate freely.

When weight and vibration are applied to the soil surface by either animals or motorized equipment, soil density increases. Many plants and soil microorganisms cannot survive and flourish under these conditions. Soil compaction is a complex problem that land managers must deal with in their day-to-day operations. Because forest soils are very susceptible to soil compaction during management activities, land managers must carefully plan and execute timber management techniques with available guidelines for maintaining long-term site productivity. The degree of soil compaction is related to the soil qualities or characteristics and equipment used. A rubber-tire skidder exerts a pressure of about 20 pounds per square inch on the soil. A crawler tractor causes about half this amount and wide flotation machines exert about five pounds per square inch. In general, the amount of compaction damage sustained is roughly equal to the pressure exerted on the soil.

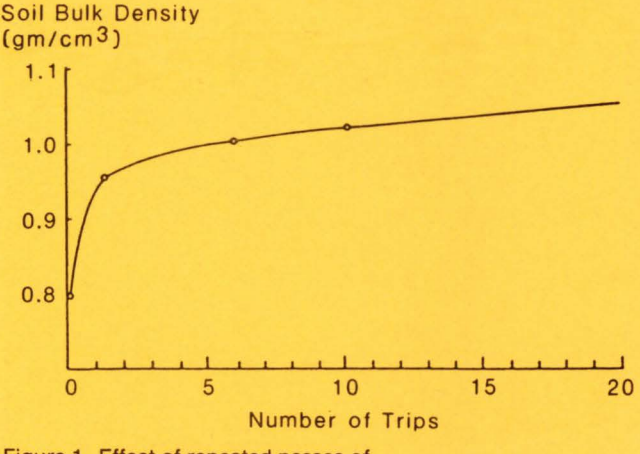

Figure 1. Effect of repeated passes of logging equipment on soil bulk density.

Soil physical properties are a good indicator of the number of trips permitted before damage occurs. The equipment exerts pressure and vibrates the soil as it moves over the surface. Research has demonstrated that the greatest amount of compaction occurs during the first few trips (Figure 1).

In precommercial thinning operations, the initial entry for timber stand management activities usually results in approximately 22 percent of the area being affected with compacted skid trails. The first commercial thinning could result in an additional 10 percent of trails, thus increasing the total affected area in compacted skid trails to 32 percent. Multi-entries for thinnings could increase the area compacted by skid trails to about 52 percent and at final harvest to over 65 percent of area in compacted skid trails.

The depth of soil compaction will also vary with soil type, site properties and equipment. The most critical compaction occurs within a few inches of the soil surface and decreases considerably with depth. The extent of the compaction and the affected rooting zone impacts tree growth. Heavily compacted soils may be indicated by slow tree growth, sparse vegetation, standing water and/or rapid runoff.

Tree feeder roots and water absorbing roots are generally located within the surface compacted zone. Because tree roots extend vertically and horizontally, the potential for damage becomes greater as compaction affects more of the rooting zone. Soil compaction reduces soil productivity by reducing pore space, aeration, infiltration rate, drainage characteristics, which adversely impacts seedling establishment, tree growth and root shoot development. Furthermore, this restricts the supply of nutrients, water and air that tree roots need to sustain proper growth throughout the rotation period. Tree growth measurements on compacted sites have shown that significant impacts can and do occur. Seedling height and diameter growth reductions of 5 to 50 percent have been reported on compacted soils (Figure 2).

For example, an average site (85 cubic feet of wood/acre/year) could be reduced to a marginal site (<60 cubic feet/acre/year of growth) and a good site (100+ cubic feet of wood/acre/year) could be changed to an average site due to compaction.

Compacted sites could require 40 to 60 years to recover if man's influence is not mitigated by subsoiling. Subsoiling shatters the compacted layer, breaking it up and loosening the soil within this layer. Subsoiling should be done approximately 3 months in advance of the planting and at a minimum depth of 18 inches. Soils with very favorable conditions, such as very active plant roots, organisms, or adverse weather (regular freezing-thawing and regular wetting-drying) cycles, are more likely to recover naturally from compaction. Coarse textured soils with weak soil structure tend to recover faster than fine-textured soils.

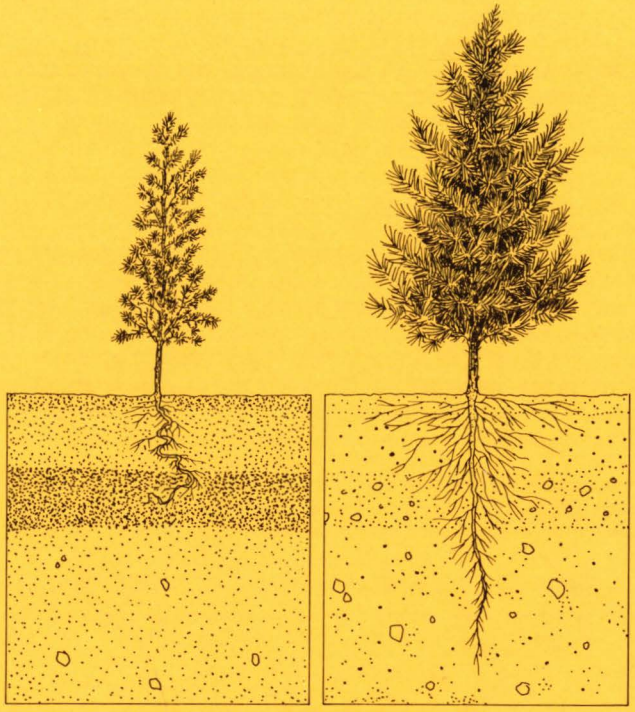

Figure 2. Compacted vs. Noncompacted Soils.

Forest land managers have three important tasks: (1) minimizing the area compacted by the management activities; (2) estimating the biological impacts and the economic costs associated with soil compaction; and (3) determining the cost of new or different techniques that could minimize soil compaction in forest soils. There is no cook book solution or easy method to accomplish these tasks. However, one approach is to substitute groundbase harvesting methods with cable or helicopter systems where feasible. Soil compaction is

minor with non-ground based systems, but costs per acre would be high in the Eastern and Southeastern United States where low volumes of timber per acre are harvested. A few land managers are using depth to water table and the type of logging equipment being used as a guide to control compaction by restricting equipment operations to periods of favorable moisture levels. Land managers may want to consider: (1) restricting activities during certain seasons; (2) using existing soil survey information; (3) laying out landings, skid trails and roads with care; and (4) writing sale contracts that specify the use of management activities that minimize soil compaction. Managers may also use predesignated skid trails and fall to lead felling operations. In any case, subsoiling is a technique that can be used to mitigate compacted sites and reduce the time needed to return an area to its full productive state.

Proper forest management can maintain the life of our soils and the future productivity of the site.

For further information contact one of these agencies in your area:

USDA Forest Service
370 Reed Road, Broomall, PA 19008

USDA Forest Service
1720 Peachtree Road, N.W., Atlanta, GA 30367

USDA Soil Conservation Service in your locale.